

# **ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE**

**CHARLIE WALTHALL, JORGE A. DELGADO  
AND STEPHEN (STEVE) DEL GROSSO**

Three parallel white lines of varying lengths are positioned diagonally in the bottom right corner of the slide, pointing towards the top right.

- \* **ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE**
- \* **REAP/GRACENET DATABASE PROGRESS REPORT**
- \* **REACTIVE NITROGEN**
- \* **NEW NITROGEN INDEX**



# ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE

- **Retrospective Review – end of 5 year research cycle**
  - **Document: Executive Summary**
    - vs Catalog of results
  - **Power point presentation**
  - **Stakeholder webinar workshop Dec. 3, 2014**
  - **Program Review Panel at later date**
- **Natural Resources & Sustainable Agriculture Programs Reorganization**
  - **Due to changing priorities**
  - **For better project alignments**
  - **Because of fewer National Program Leaders (NPL) & assistants**
    - **At least 2 new NPL hires approved**



## ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE - 2

- NP212: Soils & Emissions
  - Soils research
  - Air quality research – Air Quality Researchers Working Group
    - Including Animal systems, manure
  - GRACEnet & Livestock GRACEnet
  - REAP – will focus on soil health/sustainability
    - Renewable Economic Agricultural Practices
- Future Activities
  - USDA-EPA Ammonia Research Group
  - New Soil biology working group
  - Soil Health partnership with NRCS
  - Rangeland Wind Erosion working group
  - Data stewardship: ARS –wide (“Big Data”)
    - Internet-2 lines
    - More computing power





## ARS NP212 Climate Change, Soils & Air Emissions Program Update - 3

- **New ARS NP212/Air Quality NPL – to be hired**
- **Charlie Walthall moving to NP216 – Sustainable Systems Program**
  - **Genetics x Environment x Management interactions emphasis**
  - **More cross-disciplinary research projects**

*Thank you to all my friends & colleagues of the past & present AAQTF teams.*

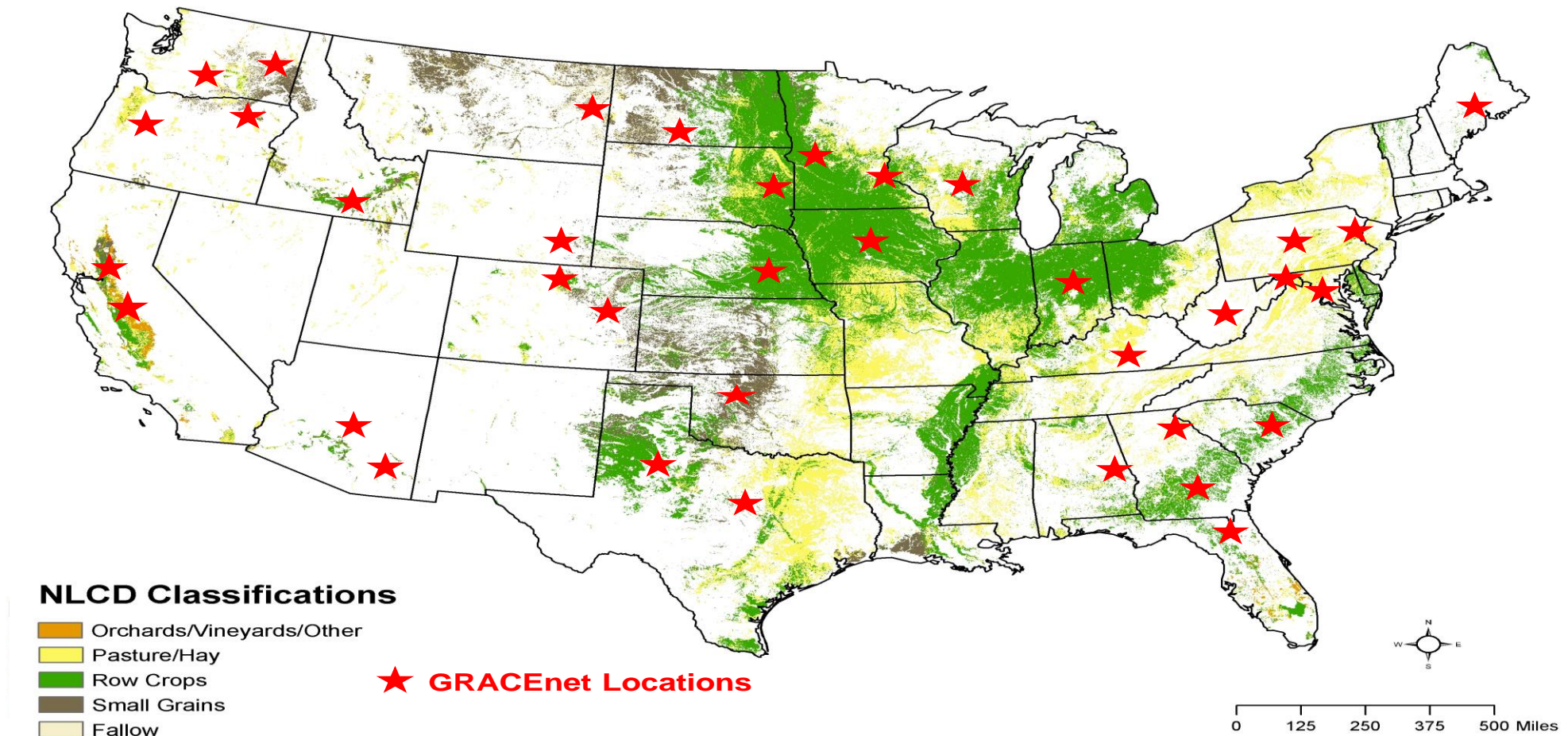
*-Charlie*

*P.S. I got married October 10!*



# \* REAP/GRACENET DATABASE PROGRESS REPORT





**Evaluate soil C status & change**

**Determine net GHG emission (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O)**

**Determine environmental effects (water, air and soil quality)**

# Progress Highlights

- Data Entry Template improvements
- More contributors - currently 34 units
- More data contributed
- Model results as well as experimental data
- Enhanced GIS and visualization
- Integration of REAP and GRACEnet into USDA ARS data portal

<http://nrrc.ars.usda.gov/arsdataportal/#/Home>

<http://nrrc.ars.usda.gov/dpasa/#/Home>



## Pre-release Statistics:

	GRACEnet	Reap
measurement records	218,672	44,026
management records	49,802	7,067
weather records	72,045	28,979
total records	367,692	95,142

Data System/Location/Table Selection

Select Data System

REAP

Select Location

St. Paul, MN Rosemount

Select Average Variable

Residue cover, soil, percent

Select Table to Display

Select

Display Selected Data

Complete Variable List

Detailed Layout

Download Menu

Table of Contents

GRACenet/REAP Filter Selection

Crops

Management

Amendments

Grazing

Crop:

Corn

Rotations:

Corn

Cover Crop:

No Selection

Keyword/Variable Selection

100m  
300ft

Table of Contents

Layers

Site Labels

MNSPRose\_StPaul\_Plots

11.88 to 18.192

18.192 to 24.504

24.504 to 30.816

30.816 to 37.128

37.128 to 43.44

43.44 to 49.752

49.752 to 56.064

56.064 to 62.376

62.376 to 68.688

68.688 to 75

MNSPRose\_Time\_Residue cover, soil

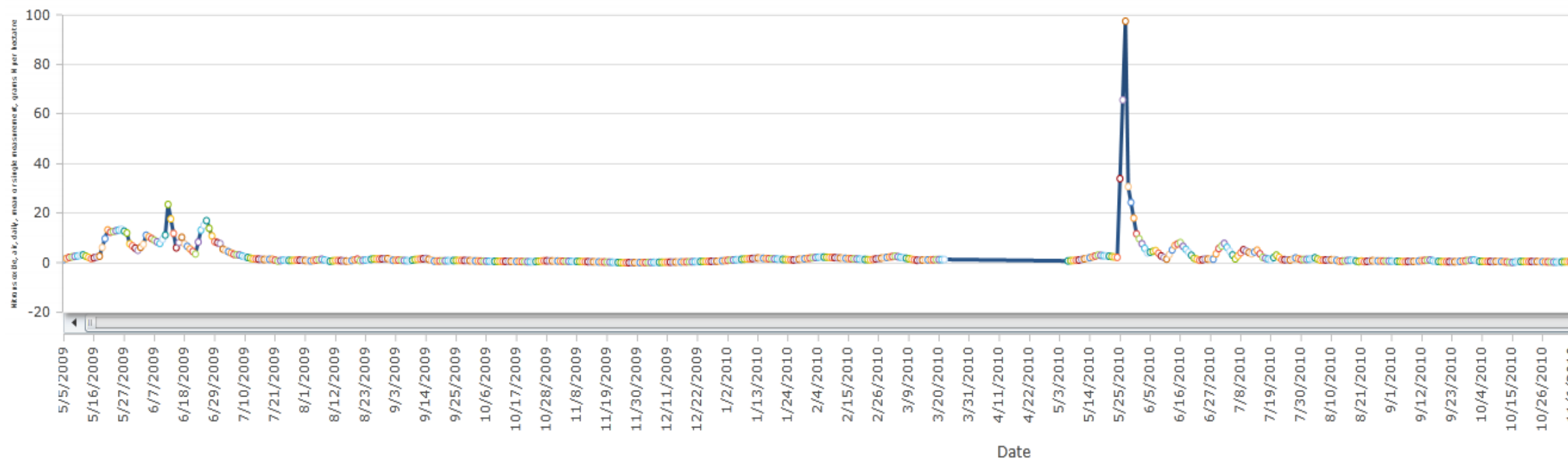
reapgis.DBO.MNSPRose\_StPaul\_Plot



Experimental Unit ID	Date	Sampling time, hours and minutes	Treatment identifier	Crop name	Chamber placement	Nitrous oxide, air, daily, mean or single measurement, grams N per hectare
COARDEC_ardecBlank0NST	05/06/2009	9:00:00 AM	COARDEC_34	Zea mays (Corn)	Across rows	1.9446
COARDEC_ardecBlank0NST	05/07/2009	9:00:00 AM	COARDEC_34	Zea mays (Corn)	Across rows	1.9203
COARDEC_ardecBlank0NST	05/08/2009	9:00:00 AM	COARDEC_34	Zea mays (Corn)	Across rows	2.0822
COARDEC_ardecBlank0NST	05/09/2009	9:00:00 AM	COARDEC_34	Zea mays (Corn)	Across rows	2.244
COARDEC_ardecBlank0NST	05/10/2009	9:00:00 AM	COARDEC_34	Zea mays (Corn)	Across rows	2.4059
COARDEC_ardecBlank0NST	05/11/2009	9:00:00 AM	COARDEC_34	Zea mays (Corn)	Across rows	2.5677

Site to be graphed: COARDEC\_ardecUAN+AgroT2C Variable to be graphed: Nitrous oxide, air, daily, mean Graph Type (default: Point) Line Graph Data MEAN=2.148; VAR=31.043; STD DEV=5.572;

Data at Fort Collins, CO SPNR for Table Measurement GHGFlux and Unit COARDEC\_ardecUAN+AgroT202NT



Is

Additional Resources

Comments

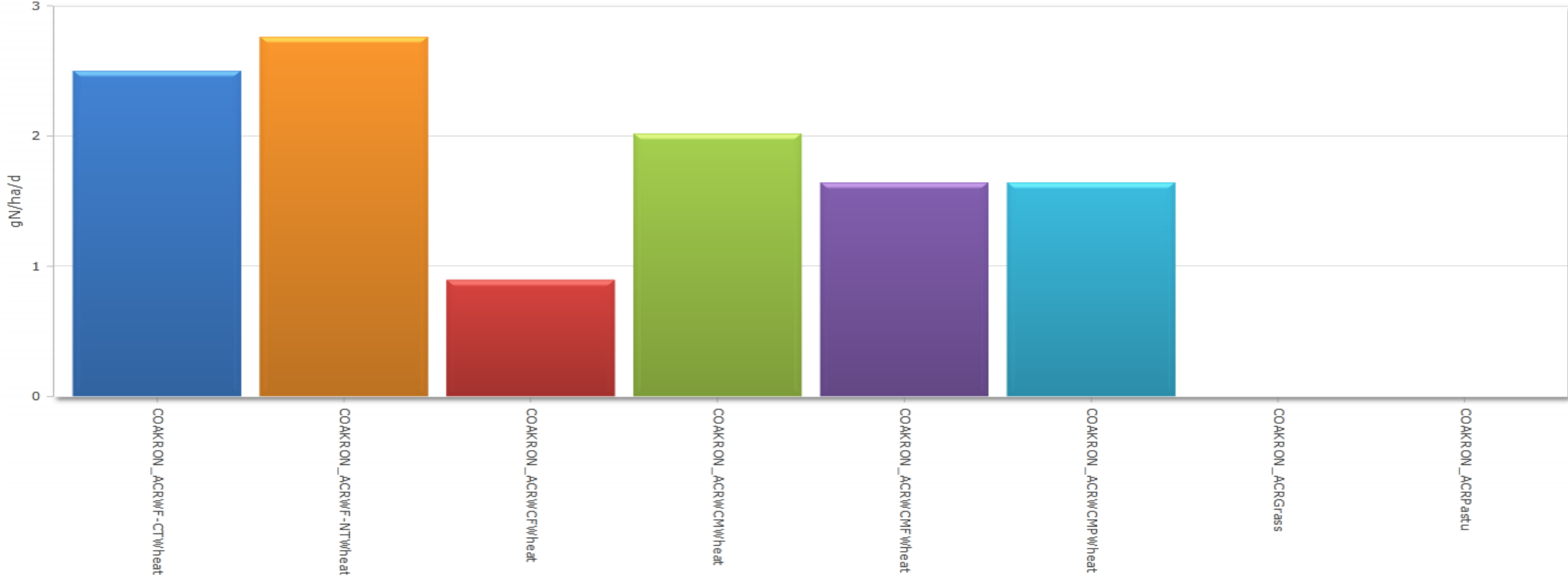
Select Model

Select Database

Select Location(s)

Select Crop

IPCC Results





els

Additional Resources

Comments

Select Model

IPCC GHG Flux

Select Database

GRACEnet

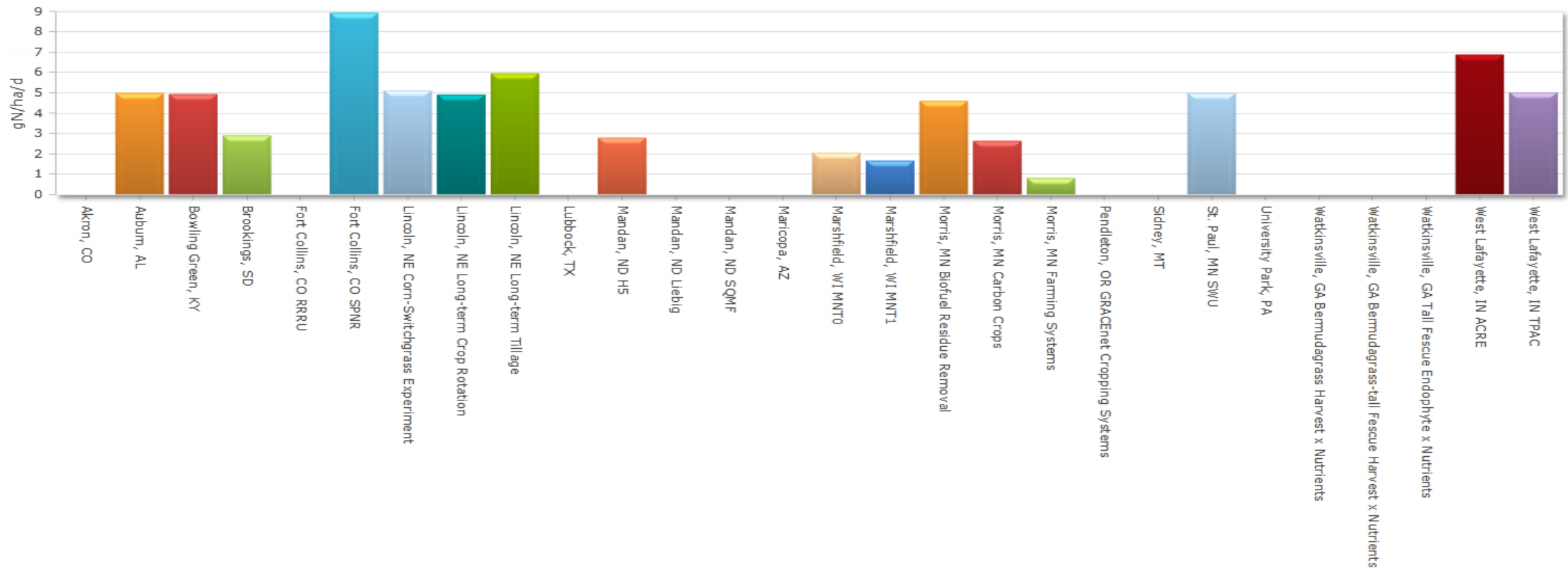
Select Location(s)

All

Select Crop

Corn

## IPCC Results



# \* REACTIVE NITROGEN



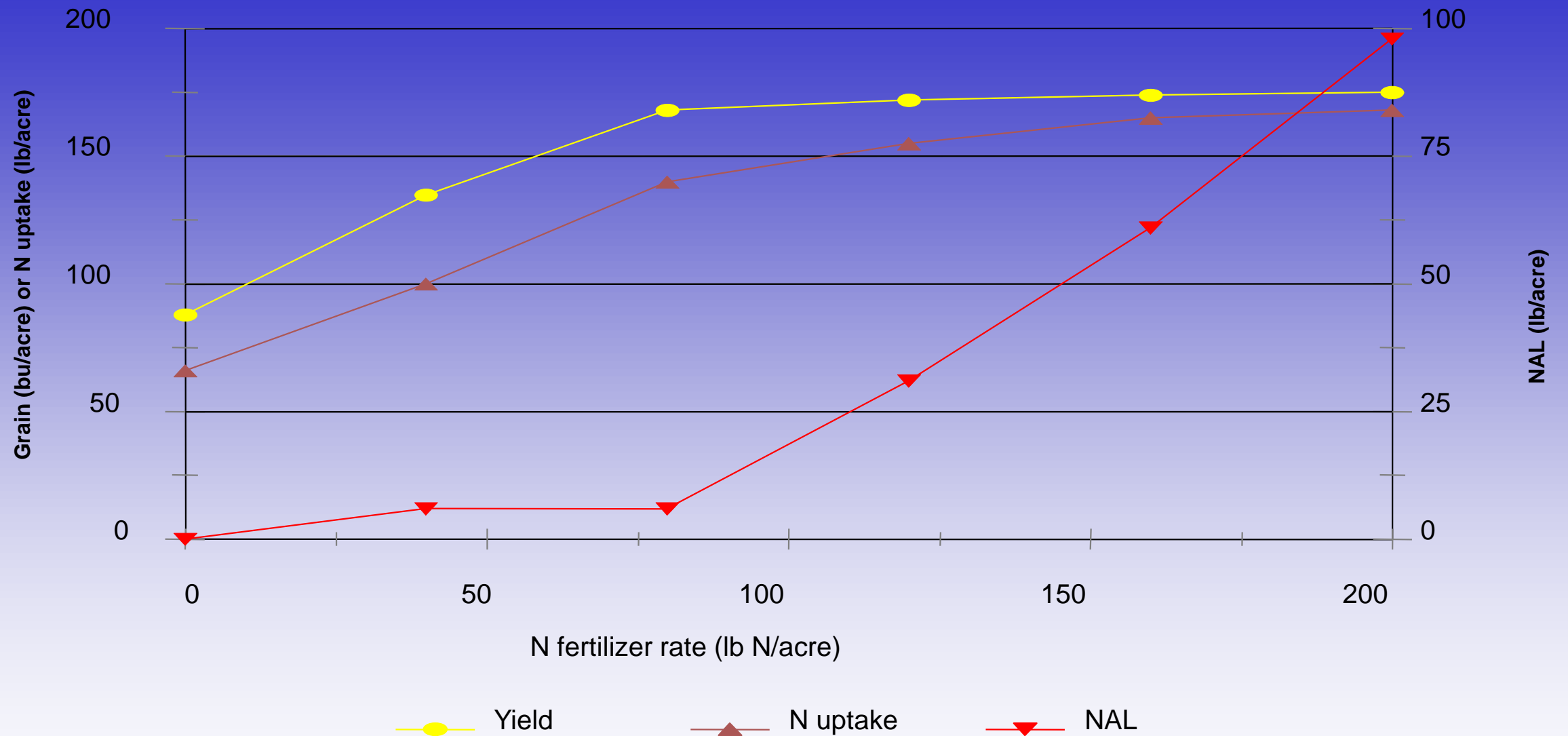
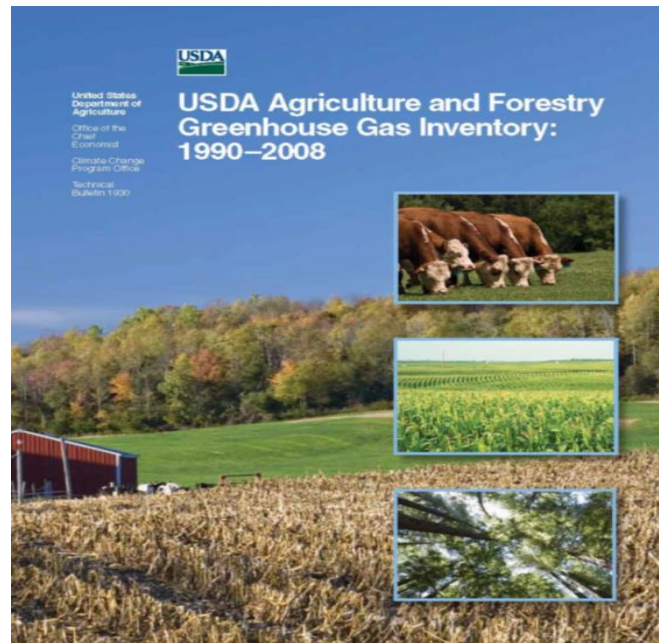


Figure 13. Effect of N fertilizer rate applications on yield and N uptake by irrigated corn (Adapted from Bock and Hergert, 1991). Potential N available to leach (NAL) assuming major pathway for losses is leaching. The NAL was estimated as  $NAL = N \text{ applied} - N \text{ uptake}$ .

# US Inventories

- Environmental Protection Agency – submitted annually to the UNFCCC
- US Department of Agriculture – compiled every 3 years





**Table 3-2 Summary of Greenhouse Gas Emissions from Cropland Agriculture, 1990, 1995, 2000-2008**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Source	<i>Tg CO<sub>2</sub> eq.</i>										
<b>N<sub>2</sub>O</b>	<b>139.5</b>	<b>144.1</b>	<b>151.8</b>	<b>160.2</b>	<b>150.2</b>	<b>147.8</b>	<b>152.4</b>	<b>153.8</b>	<b>150.5</b>	<b>151.2</b>	<b>153.9</b>
Soils Direct	103.0	109.8	115.6	122.3	115.3	111.4	118.5	117.9	114.7	116.7	118.3
Soils Indirect <sup>1</sup>	36.0	33.9	35.7	37.5	34.4	35.9	33.4	35.4	35.3	34.1	35.1
Residue Burning	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
<b>CH<sub>4</sub></b>	<b>7.9</b>	<b>8.4</b>	<b>8.4</b>	<b>8.5</b>	<b>7.6</b>	<b>7.8</b>	<b>8.5</b>	<b>7.8</b>	<b>6.8</b>	<b>7.1</b>	<b>8.2</b>
Residue Burning	0.8	0.7	0.9	0.9	0.8	0.9	1.0	0.9	0.9	1.0	1.0
Rice Cultivation	7.1	7.6	7.5	7.6	6.8	6.9	7.6	6.8	5.9	6.2	7.2
<b>CO<sub>2</sub></b>	<b>(22.6)</b>	<b>(15.6)</b>	<b>(23.5)</b>	<b>(4.3)</b>	<b>(1.7)</b>	<b>(7.2)</b>	<b>(8.3)</b>	<b>(8.0)</b>	<b>(8.9)</b>	<b>(9.2)</b>	<b>(8.3)</b>
Mineral Soils	(57.1)	(50.3)	(58.1)	(39.0)	(37.0)	(42.0)	(42.5)	(42.6)	(43.4)	(44.0)	(42.4)
Organic Soils	29.8	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3	30.3
Liming of Soils	4.7	4.4	4.3	4.4	5.0	4.6	3.9	4.3	4.2	4.5	3.8
<b>Total Emissions</b>	<b>181.9</b>	<b>187.2</b>	<b>194.8</b>	<b>203.4</b>	<b>193.1</b>	<b>190.5</b>	<b>195.2</b>	<b>196.2</b>	<b>191.9</b>	<b>193.2</b>	<b>196.2</b>
<b>Net Emissions<sup>2</sup></b>	<b>124.8</b>	<b>136.9</b>	<b>136.7</b>	<b>164.5</b>	<b>156.1</b>	<b>148.4</b>	<b>152.7</b>	<b>153.6</b>	<b>148.5</b>	<b>149.2</b>	<b>153.8</b>

Note: Parentheses indicate a net sequestration. Tg CO<sub>2</sub> eq. is teragrams carbon dioxide equivalent; CH<sub>4</sub> is methane; N<sub>2</sub>O is nitrous oxide; CO<sub>2</sub> is carbon dioxide.

<sup>1</sup> Soils Indirect N<sub>2</sub>O emissions account for volatilization and leaching/runoff.

<sup>2</sup> Includes sources and sinks.

Greenhouse gas emission from agricultural soils, primarily N<sub>2</sub>O, were responsible for the majority of total emissions, while CH<sub>4</sub> and N<sub>2</sub>O from residue burning and rice cultivation caused about 4% of emissions in 2008 (Tables 3-1, 3-2). Soil CO<sub>2</sub> emissions from cultivation of organic soils (15%) and from liming (2%) are the remaining sources. Nitrous oxide emissions from soils are the largest source in the U.S. because N<sub>2</sub>O is a potent greenhouse gas (see Chapter 1 Box 1-1) and due to the large amounts of nitrogen added to crops in fertilizer that stimulate N<sub>2</sub>O production. Emissions from residue burning are minor because only ~3% of crop residue is assumed to be burned in the U.S. (EPA 2010). Cropped soils in the U.S. are a net CO<sub>2</sub> sink mainly because reduced tillage

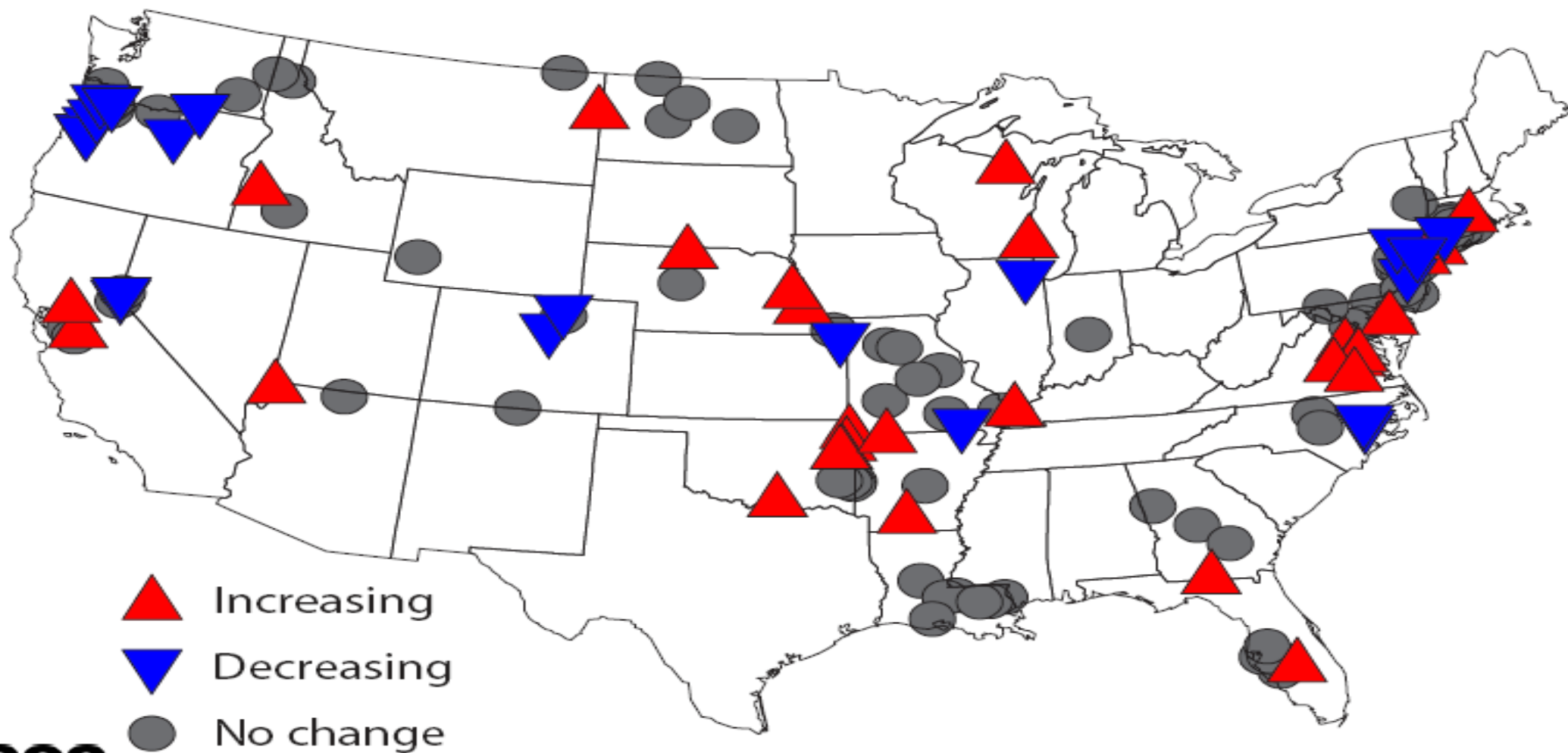
ABOUT 78%

**Table 3-3 Nitrous Oxide Emissions from Differently Cropped Soils, 1990, 1995, 2000-2008<sup>1</sup>**

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Source	<i>Tg CO<sub>2</sub> eq.</i>										
<b>Corn</b>	<b>47.5</b>	<b>42.8</b>	<b>49.7</b>	<b>53.6</b>	<b>49.3</b>	<b>47.8</b>	<b>51.6</b>	<b>51.6</b>	<b>47.1</b>	<b>59.3</b>	<b>54.0</b>
Direct	36.1	34.8	40.0	42.8	40.3	37.4	42.5	41.7	38.0	48.0	43.7
Volatilization	1.1	1.1	1.3	1.2	1.3	1.2	1.3	1.2	1.2	1.5	1.3
Leaching & Runoff	10.2	6.9	8.3	9.6	7.7	9.2	7.9	8.7	7.8	9.8	9.0
<b>Soybean</b>	<b>23.8</b>	<b>22.2</b>	<b>29.7</b>	<b>33.1</b>	<b>28.7</b>	<b>29.0</b>	<b>29.9</b>	<b>28.7</b>	<b>30.1</b>	<b>25.4</b>	<b>28.8</b>
Direct	17.1	17.7	22.5	24.5	22.0	21.2	22.5	21.6	22.8	19.3	21.8
Volatilization	0.9	0.9	1.2	1.1	1.1	1.1	1.2	1.0	1.1	1.0	1.1
Leaching & Runoff	5.8	3.6	5.9	7.4	5.7	6.6	6.2	6.1	6.2	5.2	5.9
<b>Hay</b>	<b>16.8</b>	<b>16.4</b>	<b>17.5</b>	<b>18.6</b>	<b>16.8</b>	<b>17.2</b>	<b>17.0</b>	<b>17.9</b>	<b>16.8</b>	<b>17.3</b>	<b>17.4</b>
Direct	14.3	13.7	15.4	15.8	14.4	14.6	15.0	15.3	14.7	14.9	15.2
Volatilization	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Leaching & Runoff	2.2	2.4	1.8	2.4	2.1	2.3	1.7	2.3	1.7	2.0	1.9
<b>WHEAT</b>	<b>43.0</b>	<b>43.0</b>	<b>40.0</b>	<b>40.7</b>	<b>44.5</b>	<b>44.0</b>	<b>0.0</b>	<b>0.0</b>	<b>40.0</b>	<b>0.7</b>	<b>0.3</b>

ABOUT 20%

# Nitrogen Trends in U.S. Rivers 1993 - 2003

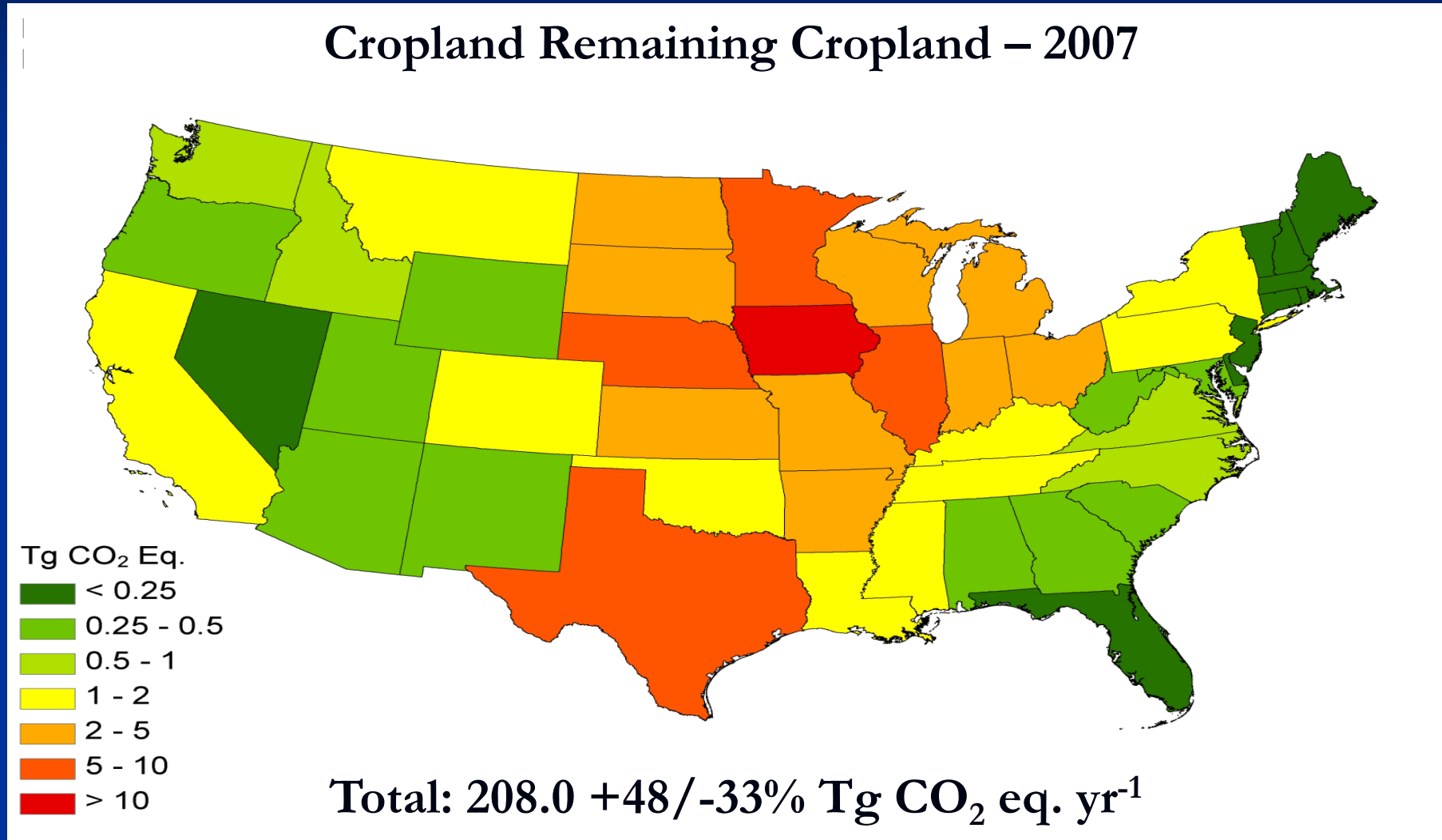


# Nitrate Trends in the Mississippi River 1980-2010



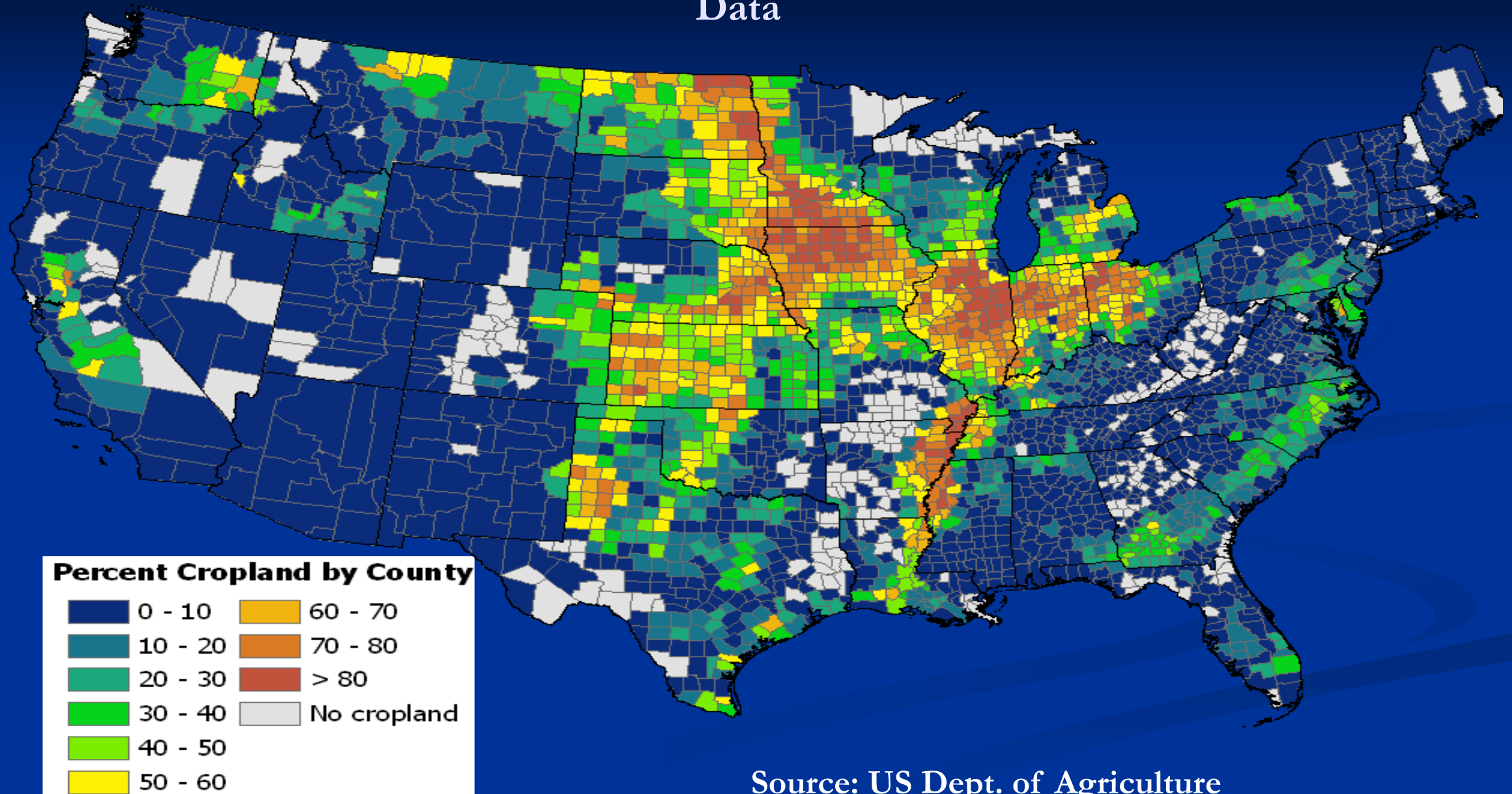


# Tier 3 Results – Direct Soil N<sub>2</sub>O Emissions



*Del Grosso et al., 2010, Global Biogeochemical Cycles*

# US National Resources Inventory (NRI): Point-Based Survey Data



Source: US Dept. of Agriculture

## averaged across three studies

2010 strip-till

2011 strip-till

2011 no-till

Treatment	Growing Season N <sub>2</sub> O–N emissions	Grain yield
	g N ha <sup>-1</sup>	Mg ha <sup>-1</sup>
N source†		
Urea	940a‡	14.45ab
PCU	633b	13.97b
SU	540c	14.73a

# Controlled-Release Fertilizer Can Increase Yields of Continuous No-till Irrigated Corn

Jorge A. Delgado<sup>1</sup>, Ardell Halvorson<sup>1</sup>, Steve Del Grosso<sup>1</sup>, Daniel Manter<sup>1</sup>, and Catherine Stewart<sup>1</sup>

<sup>1</sup>USDA-ARS Soil Plant Nutrient Research Unit, Fort Collins, CO 80526

We established six N treatments with rates varying from 0 to 224 kg N ha<sup>-1</sup> to test urea and controlled-release, polymer-coated urea (ESN).

The ESN treatments included 34 kg urea-N ha<sup>-1</sup> as a starter.

The treatments were applied to irrigated no-till corn grown in continuous corn (CC) (*Zea mays* L.) and corn-dry bean (*Phaseolus vulgaris* L.) (CB) rotations.

Nitrogen fertilizer increased yields of corn ( $P < .0001$ ).



## **Controlled-Release Fertilizer Can Increase Yields of Continuous No-till Irrigated Corn**

The average yields with ESN in CC ( $9.4 \text{ Mg dry grain ha}^{-1}$ ) were higher than with urea ( $8.8 \text{ Mg dry grain ha}^{-1}$ ) ( $P < .08$ ).

There was no difference in yields between ESN and urea with the CB.

Data suggest that at \$4.00 per bushel for corn and a 25% higher cost for the ESN, the ESN could potentially be a viable, economical source for CC.

## **2010 and 2011**

All N sources were applied at a rate of 202 kg N ha<sup>-1</sup>.

## **2014**

**(at 246 kg N ha)**

CC - ESN, 13.4 Mg dry grain ha<sup>-1</sup> > CC – urea, 12.1 Mg dry grain ha<sup>-1</sup> (P<.08)

**(Preliminary)**  
**additional studies are needed**

# \* NEW NITROGEN INDEX





ELSEVIER

Contents lists available at ScienceDirect

## Ecological Engineering

journal homepage: [www.elsevier.com/locate/ecoleng](http://www.elsevier.com/locate/ecoleng)



# Use of the new Nitrogen Index *tier zero* to assess the effects of nitrogen fertilizer on N<sub>2</sub>O emissions from cropping systems in Mexico



Vinisa Saynes<sup>b</sup>, Jorge A. Delgado<sup>a,\*</sup>, Caleb Tebbe<sup>a</sup>, Jorge D. Etchevers<sup>b</sup>, Daniel Lapidus<sup>c</sup>,  
Adriana Otero-Arnaiz<sup>c</sup>

<sup>a</sup> USDA–ARS, Soil Plant Nutrient Research Unit, 2150 Centre Avenue, Building D, Fort Collins, CO 80526, United States

<sup>b</sup> Colegio de Postgraduados, Laboratorio de Fertilidad de Suelos y Química Ambiental, Texcoco, Mexico

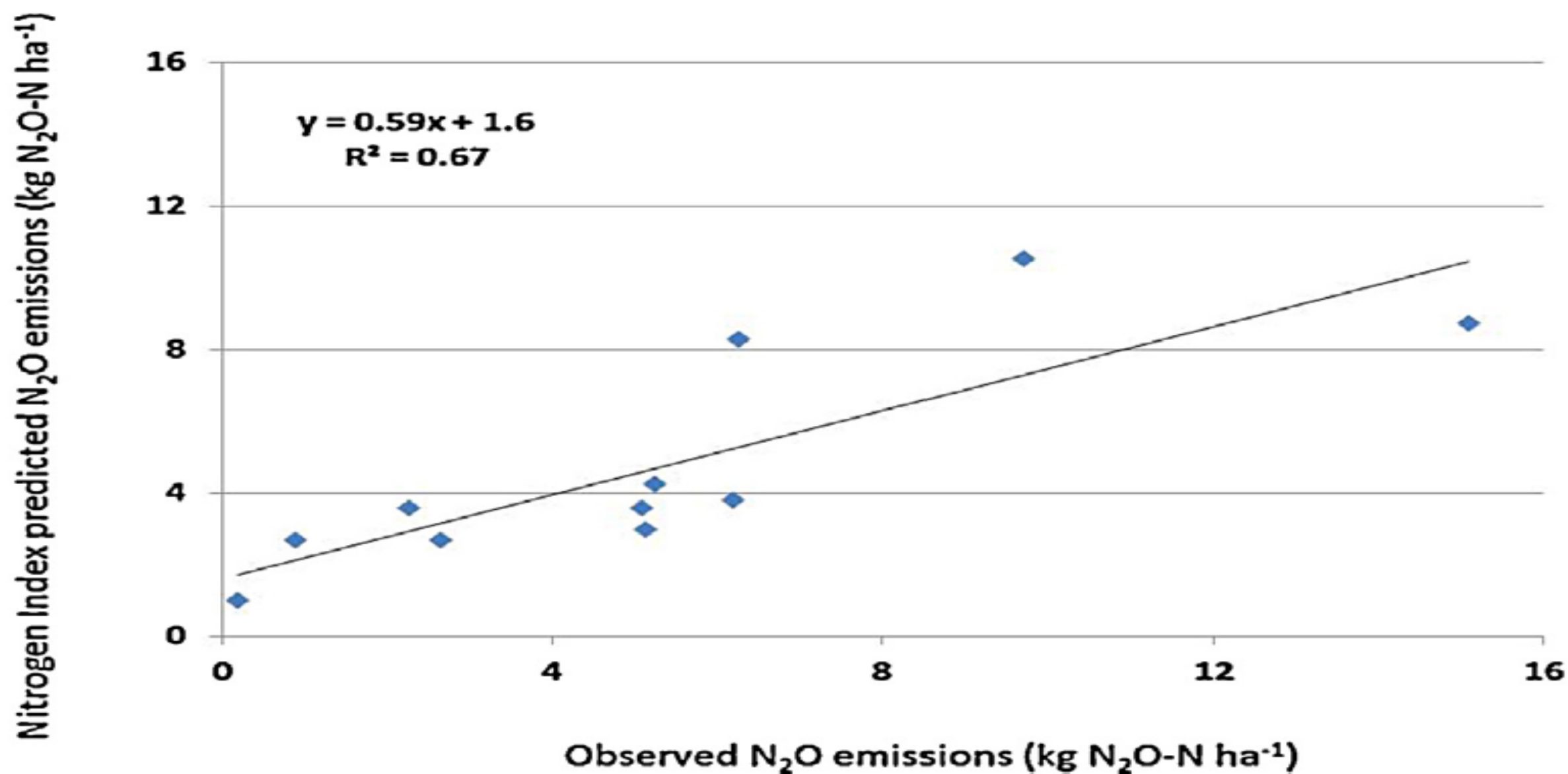
<sup>c</sup> USDA–FAS, 1400 Independence Avenue, SW, Washington, D.C. 20250, United States

### ARTICLE INFO

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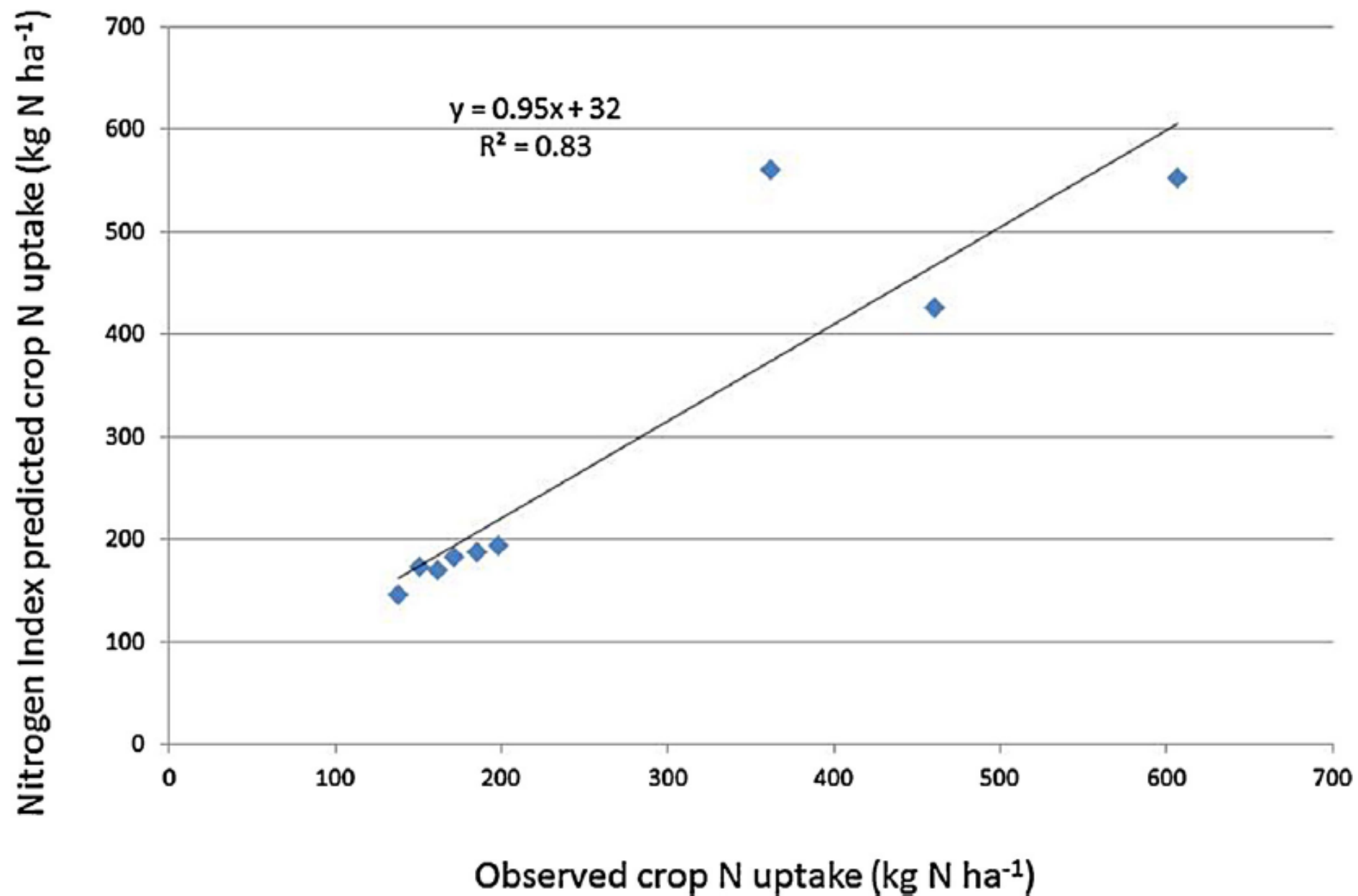
### ABSTRACT

Mexico is one of the largest users of N fertilizer in the world, and the 2nd largest user in Latin America.

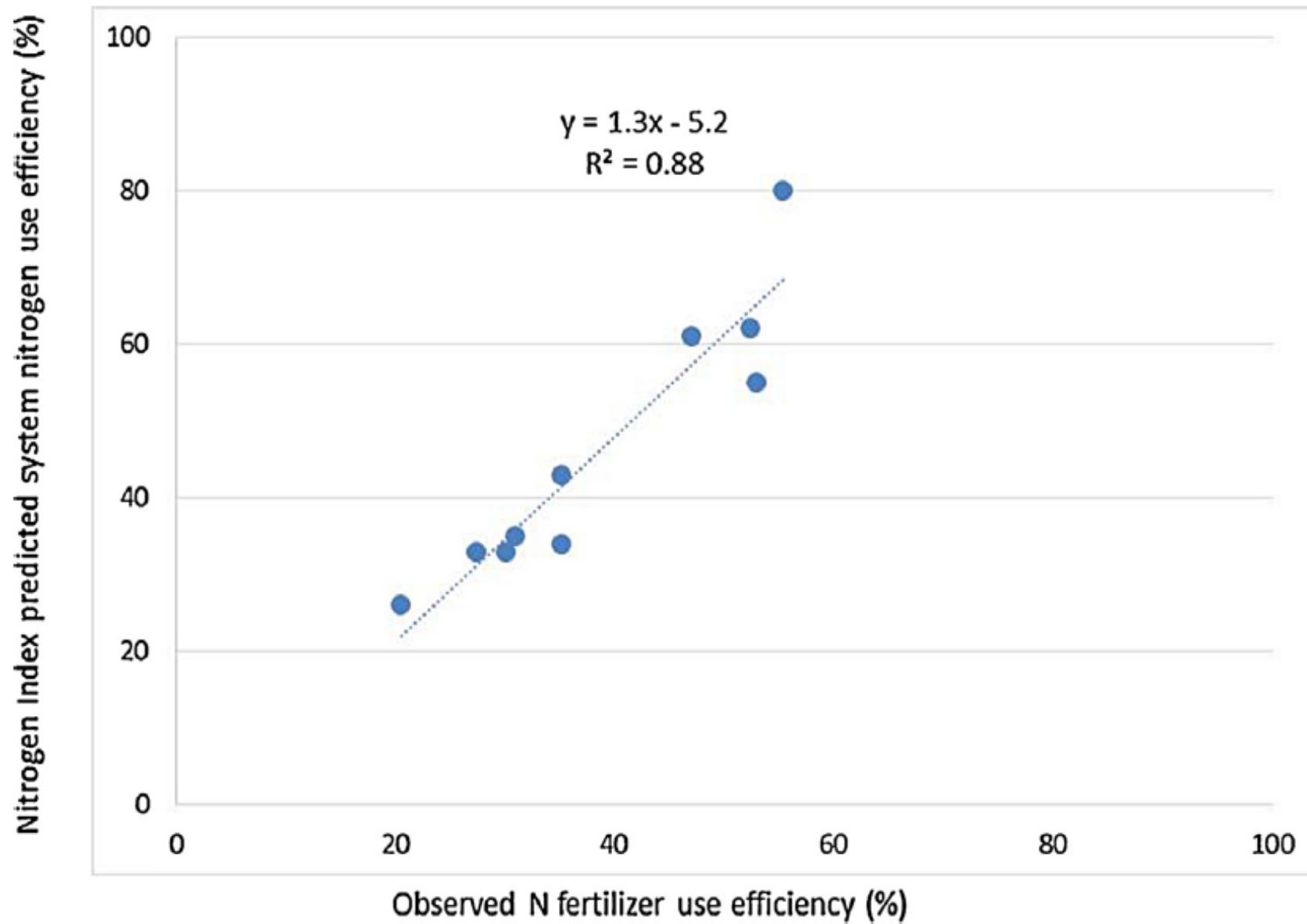


**Fig. 6.** The N<sub>2</sub>O emissions estimated by the Nitrogen Index *tier zero* tool for wheat and maize crops in Mexico versus measured N<sub>2</sub>O emissions values from the field.





**Fig| 8.** The aboveground crop N uptake estimated by the Nitrogen Index *tier zero* tool for wheat and maize crops in Mexico versus measured N uptake.



**Fig. 9.** The system nitrogen use efficiency estimated by the Nitrogen Index *tier zero* tool for wheat and maize crops in Mexico versus measured N fertilizer use efficiency.

doi:10.2489/jswc.69.3.183

## Development and testing of a new phosphorus index for Kentucky

C.H. Bolster, T. Horvath, B.D. Lee, S. Mehlhope, S. Higgins, and J.A. Delgado

**Abstract:** The phosphorus index (PI) is a field-scale assessment tool developed to identify fields most vulnerable to phosphorus (P) loss. The USDA Natural Resource Conservation Service (NRCS) recently revised its 590 Nutrient Management Standard and Title 190 National Instruction requiring that all NRCS-approved PI tools meet certain criteria. A recent study evaluating the Kentucky PI showed that it did not meet several of the criteria established by NRCS. This paper describes the development and evaluation of a revised PI for Kentucky in response to the revised 590 Standard. Important revisions to the Kentucky PI include (1) use of a component formulation, (2) incorporation of erosion and P application rates, (3) use of continuous variables, and (4) use of empirically based weighting factors. The revised Kentucky PI was evaluated against measured P loss data reported in the literature. Output from the revised PI was well correlated (Spearman's  $\rho = 0.86$ ;  $p < 0.001$ ) with the measured P loss data. Results also indicated that the revised Kentucky PI correctly assigned the appropriate risk category to the majority of fields with P loss values below or above our predefined cutoff values for low and high risk fields. On the other hand, the revised PI only correctly categorized 43% of the fields deemed to be at moderate risk. To assess whether the revised PI provided improved estimates of P loss risk, output from both the original and revised Kentucky PIs was compared against a P loss data set collected in the southern United

As each state adapted the PI framework to reflect local conditions and priorities, important state-to-state differences in PI structure have resulted. These differences include what factors are incorporated into the PI, how each factor is weighted, how the final PI value is calculated, the scientific rigor of the PI, and how PI values are interpreted in relation to P management planning (Osmond et al. 2006; Osmond et al. 2012; Sharpley et al. 2013; Sharpley et al. 2003; Weld and Sharpley 2007). Such diversity in PI formulations can result in significant variability in PI ratings and recommended P-based nutrient management planning strategies for similar field and land management conditions (Benning and Wortman 2005; Osmond et al. 2006; Osmond et al. 2012). This has led to criticism of the PI approach for evaluating P loss risk and has led to calls for a more standardized approach to PI development across states. Moreover, there is growing concern about the lack of improvement in water quality despite implementation of the PI as a risk assessment tool, particularly in the Chesapeake Bay (Executive Order 13508 2009; Kovzelove et al. 2010). The USDA NRCS, in cooperation with a working group of scientists within the Southern

**Figure 6**

Example output from combined phosphorus (P) and nitrogen (N) index graphical user interface. In this example,  $3.7 \times 10^5$  L ha<sup>-1</sup> of liquid swine manure was applied to a soil with a curve number of 86 (hydrological soil group D), soil test P of 104 mg kg<sup>-1</sup>, and an annual erosion rate of 2,240 kg ha<sup>-1</sup>.

